



Commonwealth Litter Programme

CSIR – DSI – Cefas

Marine plastic litter workshop

Day 1 – Report

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Executive Summary

Cefas (Centre for Environment, Fisheries and Aquaculture Science), CSIR (Council for Scientific and Industrial Research) and DSI (Department for Science and Innovation) co-delivered a Marine plastic litter workshop in Cape Town on 1st October 2019. Five review papers prepared to analyse achievements and gaps in South African research about marine plastic litter were discussed. The five papers focused on:

- Sources and pathways of marine plastic litter (inland and marine);
- Transport and fate of marine plastic litter;
- Ecological impacts of marine plastic litter (biota & human health);
- Ecosystem service and economic impacts of marine plastic litter;
- Marine plastic litter monitoring and methods.

The goal of the day was to (i) present the draft papers to key stakeholders, to obtain input in preparation of the papers for peer-review publication and (ii) to share knowledge about needs and priorities in future research in South Africa. Gaps in knowledge related to the five topics were also listed and discussed by all the attendees.

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1 Introduction

1.1 Opening and Welcome

Prof Linda Godfrey greeted the attendees of the workshop (listed in Appendix 1) and contextualised the event within the work for the Waste Research, Development and Innovation (RDI) Roadmap. Partners that co-delivered the workshop were introduced: Council for Scientific and Industrial Research (CSIR), Department of Science and Innovation (DSI) and the Centre for Environment, Fisheries and Aquaculture Science (Cefas).

Dr Henry Roman greeted the attendees on behalf of the DSI and declared his interest in the topic of marine litter from both a personal and professional point of view, having both the Waste and the Water RDI Roadmap's in his portfolio.

Thomas Maes presented an introduction to the Commonwealth Litter Programme (CLiP) and the work Cefas is carrying out in South Africa, presenting the five pillars (land, sea, outreach, science and education, and removal) and stating how events like this one fits the purpose of facilitating collaboration among stakeholders to improve science and tackle the problem.

1.2 Agenda

The agenda of the day (Appendix 2) consisted of plenary sessions to discuss the five review papers reporting on the state of research on marine plastic litter and microplastics in South Africa. The papers are as follows:

- (1) Sources and pathways of marine plastic litter (inland and marine) by Henk Bowman and Carina Verster (North-West University);
- (2) Transport and fate of marine plastic litter by Peter Ryan (University of Cape Town);
- (3) Ecological impacts of marine plastic litter (biota & human health) by Trishan Naidoo, Anusha Rajkaran and Sershen Naidoo (University of the Western Cape);
- (4) Ecosystem service and economic impacts of marine plastic litter by Sumaiya Arabi and Anton Nahman (CSIR);
- (5) Marine plastic litter monitoring and methods by Peter Ryan (University of Cape Town).

The aim of the papers is to understand gaps and needs in research, providing background knowledge to help in deciding where research effort should be focused in the future, in order to obtain useful and relevant results in the most efficient way.

The five reviewing sessions (one per paper) followed a similar schedule: the paper was presented by the lead author; a comprehensive review was carried out by one or two independent reviewers appointed by CSIR; and an open discussion was held with all the attendees. Review comments were shared directly with the author and will be considered for the next revision (due 18th October).

2 Reviewing sessions

2.1 (1) Sources and pathways of marine plastic litter (inland and marine)

Prof Henk Bowman presented the first review paper '*Scientific review of marine plastic pollution in South Africa - Land-based sources and pathways of marine plastics in a South African context*' that he prepared with his team about sources of marine litter. In order to discuss sources of marine litter, the paper starts presenting statistics on the production and recycling of plastics in South Africa. The paper focuses on land-based sources, including the mismanagement of waste in informal settlements, the production of microfibers from clothes, the production of plastic litter and microplastics from packaging and other sources. The path, movements and sinks of plastic litter and microplastics in air, land and waterways were also discussed. The gaps in knowledge identified by the paper include the ecotoxic effects of plastics; the waste treatment effectiveness; the effect of rubber, microbeads, and nanoplastics; a characterization of the aerial transport, the chemicals linked to the particles, the seasonal dynamics and sinks. Prof Bowman also presented a list of improvements to the paper already identified by the authors.

The paper was reviewed by Fiona Preston-Whyte. These review comments were shared directly with the author and will be considered for the next revision (due 18th October).

2.2 (2) Transport and fate of marine plastic litter

Prof Peter Ryan was the author of the second review paper '*Transport and fate of marine plastics*'. Several points were discussed during the presentation including the rate of marine plastic litter production worldwide and in South Africa that are currently accepted (with a focus on the relative importance of marine and land sources); the mismatch between the estimate amount of plastics in the marine environment and the actual observations; models suggested to match the latter gap; the limited distance covered by litter once in the environment; the effect on the budget calculations (and data collection) of buried litter, beach clean-ups, and episodic inputs; the seafloor as the real sinks of marine plastic litter and dynamics of accumulation at the bottom of the sea to explain the low amount of litter observed there. The gap in research identified by the paper were a complete mass budget worldwide for plastics; the better understanding of fluxes and final sinks; and a better estimate of the magnitude of land-based inputs.

The paper was reviewed by Dr David Glassom and Dr Umberto Binetti. These review comments were shared directly with the author and will be considered for the next revision (due 18th October).

2.3 (3) Ecological impacts of marine plastic litter (biota & human health)

Dr Trisha Naidoo presented a summary of his review paper '*Ecological impacts of marine plastic litter: A South African perspective*'. The paper focused on entanglement and ingestion of marine litter over a range of marine creatures (both vertebrates and invertebrates). The paper presents evidence of the impact of plastic and microplastics, including decreased growth, feeding and reproductive output, inflammation, endocrine disruption, and liver toxicity. The study identified

major gaps in knowledge such as the absence of standardised protocols and infrastructure, absence of data about ingestion by commercially valuable species and lack of knowledge about the sublethal effect passing from biota to humans. Dr Naidoo also showed that these gaps should be filled with data collected in country because South Africa has specific combination of species and biological interactions and data collected elsewhere could reflect different level of contaminants.

The paper was reviewed by Prof. Coleen Moloney and Dr Adil Bakir. These review comments were shared directly with the author and will be considered for the next revision (due 18th October).

2.4 (4) Ecosystem service and economic impacts of marine plastic litter

The review paper '*Ecosystem service and economic impacts of marine plastic litter: State of South African research*' presented by Mr Anton Nahman discussed the impact of marine litter on ecosystem services and the economy. International publications were used to create a framework against which South African literature was compared. Mr Nahman introduced impacts on ecosystem services such as provisioning (fisheries, aquaculture), cultural (recreation and aesthetics, heritage), and supporting (habitat and biodiversity); and on economy through direct costs (reduced performances of industry and activities), indirect costs (such as problems to human health) and non-market costs (scenic, spiritual and cultural values). The gaps in research are significant according to this review paper because South African studies are isolated, localised and outdated. Research is needed to correctly quantify the impacts over ecosystem services and over the economy.

The paper was reviewed by Takunda Chitaka. These review comments were shared directly with the author and will be considered for the next revision (due 18th October).

2.5 (5) Marine plastic litter monitoring and methods

The review paper '*Monitoring marine plastics*' about monitoring in South Africa was presented by Prof Peter Ryan. The scopes of monitoring were identified (evaluating mitigation, identifying new problems and checking compliance) and the pro and cons of monitoring macro- and microplastics were assessed. The paper reports several studies of marine plastics in the sea, on beaches, and in biota (turtles and birds) and states that the gap in knowledge about accumulation and turnover rates is a major problem to interpret the variations in standing stocks. The paper therefore suggests to survey inputs of litter in the marine environment (drains and rivers, origin of litter on beaches), accumulation rates, the amount and composition of plastics on the seabed. For microplastics, ingestion by biota (and contaminants effects), soft sediment and tidal stranding should be the focus.

The paper was reviewed by Thomas Maes. These review comments were shared directly with the author and will be considered for the next revision (due 18th October).

3 Mapping key gaps in data/knowledge and research needs/priorities

The last session of the day was an interactive exercise. Five flipcharts were placed around the room, each dedicated to one of the topics analysed in the review papers. Prof Godfrey asked the attendees to consider the discussion happening in the room and their own personal expertise and write on each flipchart the major gaps and the priorities that could help identify the direction that future research in South Africa should follow. After the exercise, Prof Godfrey presented the results. The gaps listed are transcribed in Table 1 while pictures of the actual flipcharts are reported in Appendix 3.

Table 1 List of major gaps in knowledge and priorities linked to the five topics discussed in the review papers as listed by workshop attendees.

<p>Topic 1: Sources and pathways of marine plastic litter (inland and marine) (Figure 3-1, Appendix 3)</p>
<ul style="list-style-type: none"> • Rivers as sinks and sources – health and human interaction risk • Clear understanding of link between land and sea – how much leaking via different rates from different sources • Industry/producer data • Flying plastic? • What is the biggest source that can be targeted with the most cost effective and efficient method? • What is the extent of imported waste? • What are municipalities doing to prevent illegal dumping that eventually result to marine litter? • What is RSA doing to implement source separation of waste? • How do we address human behaviour (not to litter/dump) • How much waste comes from areas without collection facilities? – what (categories) • Understanding fluxes sediment->biota->sea->atmosphere
<p>Topic 2: Transport and fate of marine plastic litter (Figure 3-2, Appendix 3)</p>
<ul style="list-style-type: none"> • Accumulation at the back of the beach/benthic ocean features • How much plastic occurs between the surface of the ocean and seabed – “floating” but not at the surface • What data do we need to improve the accuracy of the models specifically to reflect land-based inputs transport? • Does estuarine type + estuarine features affect transport? • Can we use acoustic/satellite telemetry to track plastic litter? • Litter turnover rates • Litter wash-up rates and distribution patterns on coasts • Release experiments with trackers • Ratios between microplastics • Microplastics in estuary sediments – fast flowing less than slow flowing • Episodic events/ high vs low flows and influence on mobilisation and transport • How climate changes may affect the fate of marine litter • Mass balance – input + sinks • Do we understand flows and end points?
<p>Topic 3: Ecological impacts of marine plastic litter (biota & human health) (Figure 3-3, Appendix 3)</p>

- ID hotspots that exclude aquaculture along coast
- Quantify alternative habitats (lethal and behavioural)
- Quantify amount of plastic in fish sold in local fish shop
- Clear understanding of link between plastic in environment and human health (what is the risk?)
- Dose-response effects for individuals and population -> focus on vulnerable life stages
- Exposure and risk maps for sensitive areas
- Scaling effect on individual to community population level
- Understand the difference between plastic associated pollution and other toxins pollutants (e.g. heavy metals) and their effects on biota
- Particle and additive toxicity -> separate and combined toxicity
- Level of public awareness must be increased – how to measure behavioural and attitude change? (short and long term)
- Polymer specific toxicity (also copolymer)
- Impacts on human morbidity quantified by disability adjusted life years (DALY)
- Discrepancies between experiments and field results

Topic 4: Ecosystem service and economic impacts of marine plastic litter (Figure 3-4, Appendix 3)

- Life cycle assessments of different plastic polymers combined with additives (chemical) to plastics
- Valuation of ecosystem damage + foregone economic opportunities
- Comparison of ES loss caused by plastic litter vs alternative materials
- Compare costs of solutions vs costs on ES
- Is the main ES impact through aesthetic/human well-being? Can this be valued?
- What is the cost to SA marine litter?
- Benefit of producing/recycling carbon footprint of plastic
- Economic impact of marine litter to South African ports (port closure?)
- Resource value of the plastics?
- How much industry (Plastic SA) pay for clean-ups
- Can we [...] product in the environment?
- What is the value of all plastic in the SA ocean?

Topic 5: Marine plastic litter monitoring and methods (Figure 3-5, Appendix 3)

- Landfills management must comply with landfill regulations
- Numbers, sources and types
- Efficacy of measures
- Power of monitoring approach
- Adequate freshwater monitoring methods
- Microplastic isolation, quantities and characterization methods – standardised protocols
- Storm water profiles + waste water treatment works along the coast + outfalls
- Monitoring of remote sites for background (global) trends
- Where are the gaps in critical data to understand ecological and economic impact and what monitoring progress can we put in place (+ cost) to get this data?
- Measuring aerial deposition at sea? Remote weather station monitoring
- Harmonising of reporting units
- More specific characterization (macro-plastic)

Appendix 1: List of attendees

Douw Steyn	PlasticsSA
Henk Bouwman	North-West University (NWU)
Mark Graham	GroundTruth
Anusha Raykaran	University of the Western Cape (UWC)
Tony Ribbink	Sustainable Seas Trust (SST)
Sumaiya Arabi	Council of Scientific and Industrial Research (CSIR)
Toshka Barnardo	Sustainable Seas Trust (SST)
Takunda Chitaka	University of Cape Town
Reza Daniels	University of Cape Town
Carina Verster	North-West University (NWU)
Olusola Olaitan Ayeleru	University of Johannesburg (UJ)
Lorien Pichegru	Nelson Mandela University (NMU)/SST
Henry Roman	Department of Science and Innovation (DSI)
Trishan Naidoo	University of the Western Cape (UWC)
Anton Nahman	Council of Scientific and Industrial Research (CSIR)
Lara van Niekerk	Council of Scientific and Industrial Research (CSIR)
Stephen Lamberth	Department of Environment Forestry and Fisheries (DEFF)
Peter Ryan	University of Cape Town
Yazeed Peterson	Department of Environment Forestry and Fisheries (DEFF)
Carl Van Der Lingen	Department of Environment Forestry and Fisheries (DEFF)
David Glassom	University of KwaZulu-Natal (UKZN)
Coleen Moloney	University of Cape Town
Linda Godfrey	Council of Scientific and Industrial Research (CSIR)
Thomas Maes	Centre for Environment, Fisheries and Aquaculture (Cefas)
Fiona Preston-Whyte	Cefas
Adil Bakir	Cefas
Umberto Binetti	Cefas
Josie Russell	Cefas

Appendix 2: Agenda

8:30 – 8:45	Welcome and introductions	Henry Roman
8:45 – 9:00	Background to this science review	Linda Godfrey
9:00 – 9:20	(1) Sources and pathways of marine plastic litter (inland and marine)	Henk Bouwman
9:20 – 9:30	Review comments from external reviewer(s)	Fiona Preston-Whyte
9:30 – 10:00	General discussion on paper, missing info, new sources	All
10:00 – 10:20	TEA/COFFEE BREAK	
10:20 – 10:40	(2) Transport and fate of marine plastic litter	Peter Ryan
10:40 – 10:50	Review comments from external reviewer(s)	David Glassom and Umberto Binetti
10:50 – 11:20	General discussion on paper, missing info, new sources	All
11:20 – 11:40	(3) Ecological impacts of marine plastic litter (biota & human health)	Trishan Naidoo
11:40 – 11:50	Review comments from external reviewer(s)	Adil Bakir and Coleen Moloney
11:50 – 12:20	General discussion on paper, missing info, new sources	All
12:20 – 13:00	LUNCH	
13:00 – 13:20	(4) Ecosystem service and economic impacts of marine plastic litter	Anton Nahman
13:20 – 13:30	Review comments from external reviewer(s)	Takunda Chitaka
13:30 – 14:00	General discussion on paper, missing info, new sources	All
14:00 – 14:20	(5) Marine plastic litter monitoring and methods	Peter Ryan
14:20 – 14:30	Review comments from external reviewer(s)	Thomas Maes
14:30 – 15:00	General discussion on paper, missing info, new sources	All
15:00 – 15:20	TEA/COFFEE BREAK	
15:20 – 16:30	Mapping key gaps in data/knowledge and research needs/priorities	All

Appendix 3: Flipcharts

The appendix reports the pictures of the flipcharts used during the last session of the workshop to list gaps in knowledge and in data, and needs and priorities in research linked to the five topics discussed in the review papers.

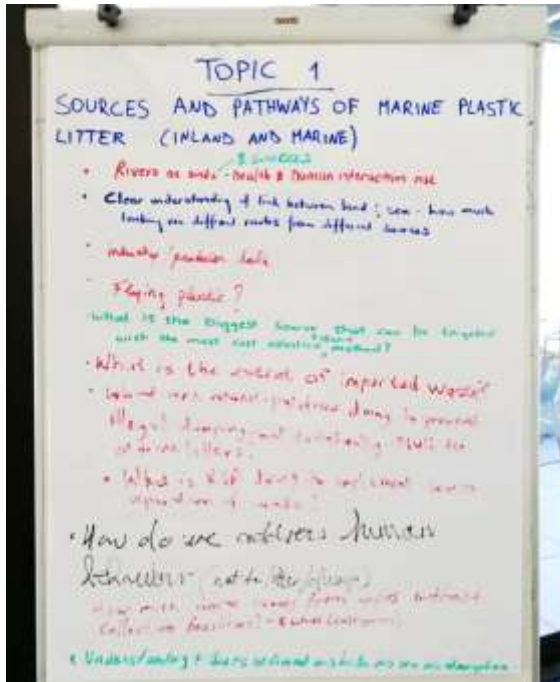


Figure 3-1 Flipchart for topic 1 'Sources and pathways of marine plastic litter (inland and marine)'

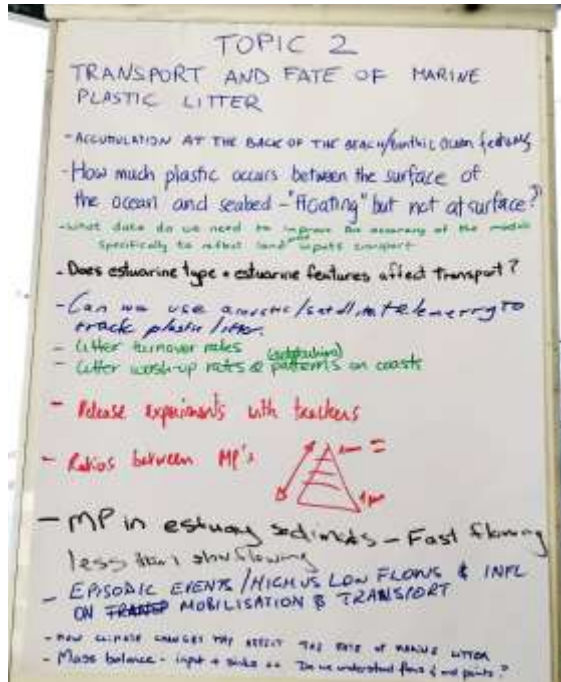


Figure 3-2 Flipchart for topic 2 'Transport and fate of marine plastic litter'

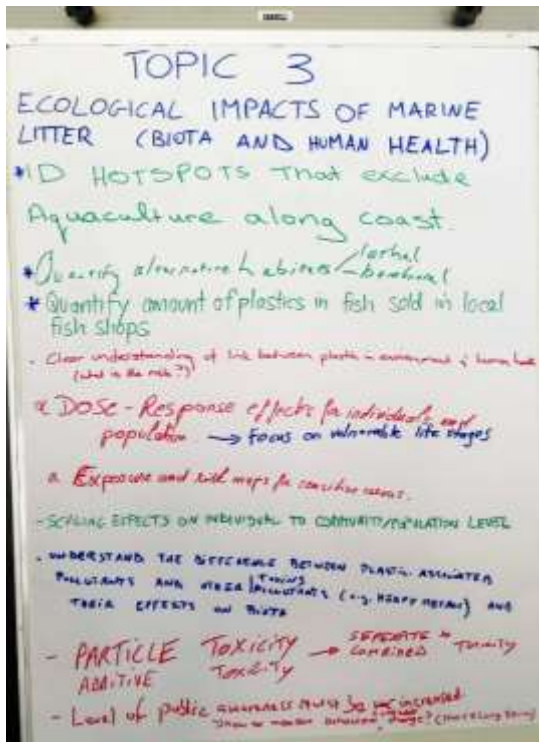
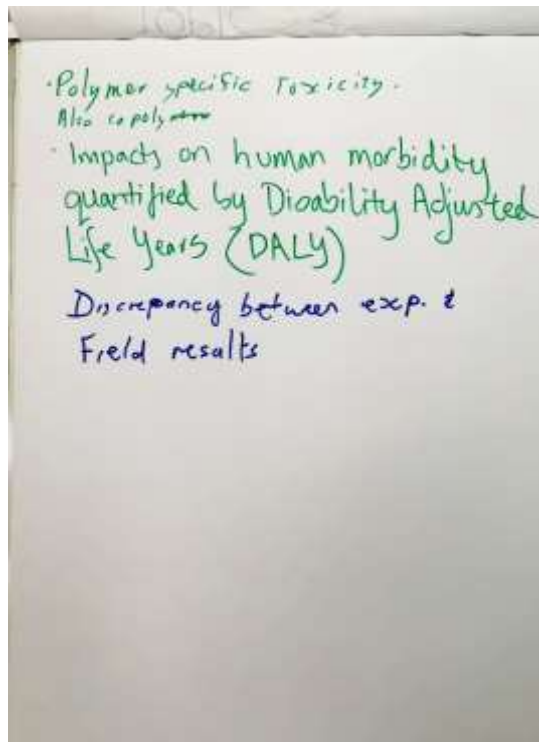


Figure 3-3 Flipcharts for topic 3 'Ecological impacts of marine plastic litter (biota & human health)'



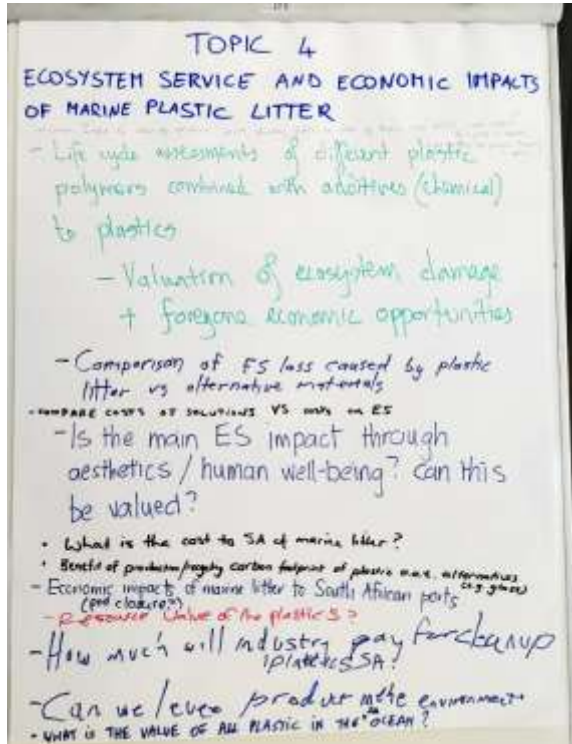


Figure 3-4 Flipchart for topic 4 'Ecosystem service and economic impacts of marine plastic litter'

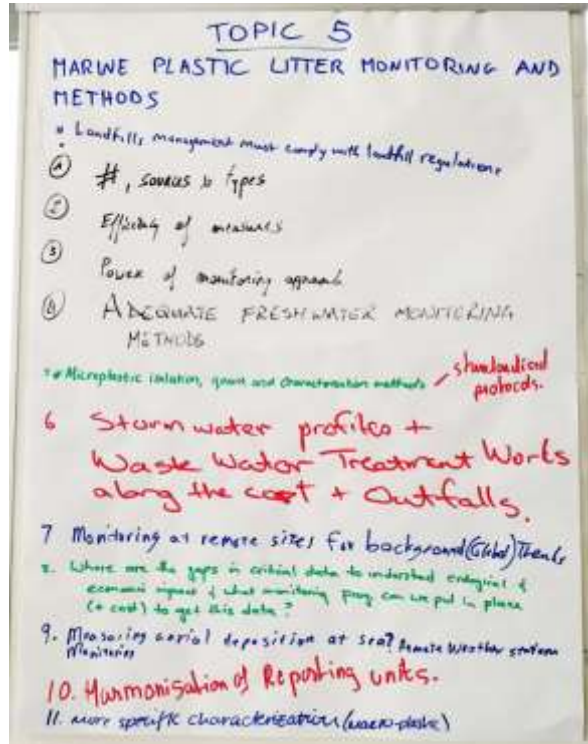


Figure 3-5 Flipchart for topic 5 'Marine plastic litter monitoring and methods'



Centre for Environment Fisheries & Aquaculture Science



About us

We are the Government's marine and freshwater science experts. We help keep our seas, oceans and rivers healthy and productive and our seafood safe and sustainable by providing data and advice to the UK Government and our overseas partners.

We are passionate about what we do because our work helps tackle the serious global problems of climate change, marine litter, over-fishing and pollution in support of the UK's commitments to a better future (for example the UN Sustainable Development Goals and Defra's 25 year Environment Plan).

We work in partnership with our colleagues in Defra and across UK government, and with international governments, business, maritime and fishing industry, non-governmental organisations, research institutes, universities, civil society and schools to collate and share knowledge.

Together we can understand and value our seas to secure a sustainable blue future for us all, and help create a greater place for living.

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In our laboratories in Lowestoft and Weymouth we:

- safeguard human and animal health
- enable food security
- support marine economies.

This is supported by monitoring risks and disease in water and seafood; using our data in advanced computer models to advise on how best to manage fish stocks and seafood farming; to reduce the environmental impact of man-made developments; and to respond to serious emergencies such as fish disease outbreaks, and to respond to oil or chemical spills, and radioactivity leaks.

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